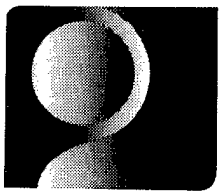
integrated
energy
systems

ENERGY AUDIT OF IRELAND ARMY COMMUNITY HOSPITAL FORT KNOX, KY



VOLUME 1 OF 5: EXECUTIVE SUMMARY

Contract #DACA21-84-C-0578

August 18, 1986

Final Report submitted to:

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EXECUTIVE SUMMARY

1. EXECUTIVE SUMMARY

1.1 Introduction

1.1.1 Scope of Work

The complete Scope of Work (SOW) is included in Appendix 2 but the essential elements are repeated below. Integrated Energy Systems/Koenigshofer Engineers, Inc. (IES/KE) was contracted by the Louisville District of the US Army Corps of Engineers in June 1985 to perform a complete energy audit and analysis of Ireland Army Community Hospital (IACH) and nine auxiliary facilities at Fort Knox, Kentucky. All of the buildings are permanent structures with a remaining life of over 20 years. They are listed in Table 1-1, and shown on the map in Figure 1-1 with the exception of Bldg 864 which is a small chiller building serving the hospital which is too small to show. Shown below is a brief description of the SOW.

BRIEF DESCRIPTION OF WORK: The Architect-Engineer (AE) shall:

1. Perform a complete energy Audit and Analysis of the entire hospital facility.

2. Identify all Energy Conservation Opportunities (ECOs) including low cost/no cost ECOs and perform complete evaluations of each.

3. Prepare programming documentation for all Energy Conservation Investment Program (ECIP) projects [DD Form 1391, Life Cycle Cost Analysis Summary Sheet with backup calculations and Project Development Brochure (PDB)].

4. Prepare implementation documentation for all justifiable energy conservation opportunities.

5. List and prioritize all recommended energy conservation opportunities.

6. Prepare a comprehensive report which will document the work accomplished, the results and the recommendations.

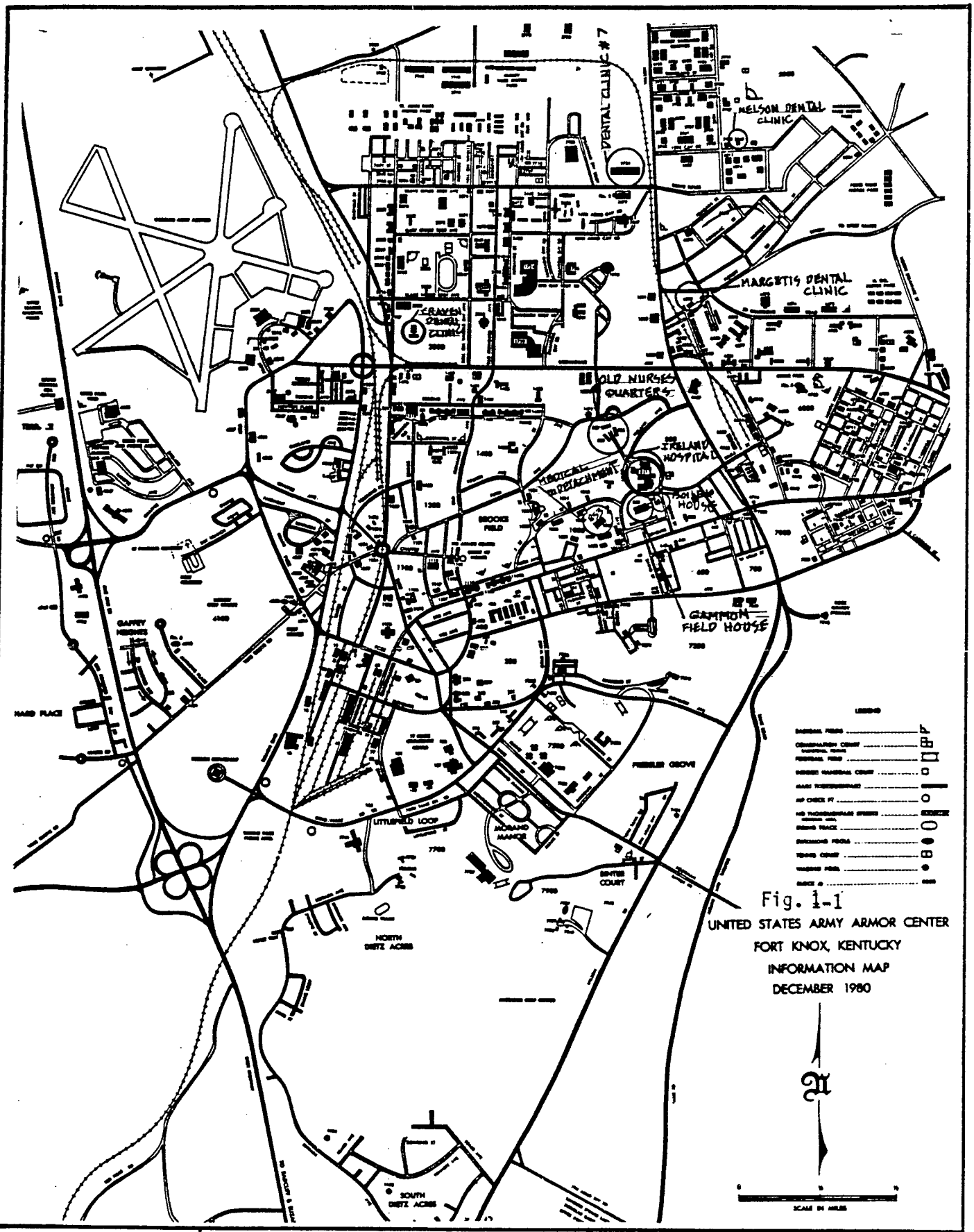

Fig. 1-1
UNITED STATES ARMY ARMOR CENTER
FORT KNOX, KENTUCKY
INFORMATION MAP
DECEMBER 1980

FIGURE: 1-1	FT. KNOX SITE PLAN	IES/KE INC. chapel hill, north carolina sacramento, california

Table 1-1. List of Facilities Audited

IACH Complex
- Bldg 851 - Ireland Army Community Hospital
- Bldg 852 - Boiler House
- Bldg 864 - Chiller Building (serving hospital only)

Auxiliary Facilities
- Bldg 850 - Gammon Field House
- Bldg 853 - Medical Detachments Bldg
- Bldg 855 - Old Nurses Quarters
- Bldg 856 - Old Nurses Quarters
- Bldg 857 - Old Nurses Quarters
- Bldg 2000 - Craven Dental Clinic
- Bldg 6289 - Margetis Dental Clinic
- Bldg 5949 - Nelson Dental Clinic
- Bldg 2724 - Dental Clinic #7

1.1.2 Organization and Purpose of this Submittal

The submittals for this report include the following, each separately bound:
- Energy Audit of Ireland Army Community Hospital, Ft. Knox, KY
  Vol. 1 of 5 - Executive Summary
- Energy Audit of Ireland Army Community Hospital, Ft. Knox, KY
  Vol. 2 of 5 - Ireland Army Community Hospital and Auxiliary Facilities
- Vol. 3 of 5 - Appendix 1, Programming and Implementation Documents
- Vol. 4 of 5 - Appendix 2.
  Reference Materials & Results
  SOW & Mtg. Minutes
  References
  EMCS Points List
  Field Test Reports
  Calculations for Not Recommended ECOs
- Vol. 5 of 5 - Field Notes
  (submitted with interim report only to Ft. Knox DEH, MEDDAC and Louisville, COE)

In this volume, the first four chapters provide important information about methods & assumptions. In Chapter 5 current energy use at IACH is discussed. Chapters 6-11 address each of the major energy consuming functions at IACH e.g. lighting. Existing conditions are described in detail, while proposed ECOs are outlined.

The Auxiliary Facilities are thoroughly described and the proposed ECOs are detailed in Chapters 12-19.

1.2 Present Energy Consumption

1.2.1 IACH

The estimated energy consumption at IACH as predicted by the BLAST computer model is shown in Table 1-2. A comparison of BLAST predicted electricity use with actual meter data showed little difference (less than 1%). Metered gas consumption data was not available. The total energy cost in 1985 is estimated at approximately $1.4 million. This consumption is compared to other hospitals in Figure 1-2. As indicated, natural gas consumption at IACH is quite high. This is partially explained by the absorption chillers, though St. Dominics also had absorption chillers. Electricity consumption at IACH is slightly lower than the other hospitals listed, due to the previous conservation efforts at IACH such as reducing corridor and parking lot lighting.

Table 1-2. Current Estimated Energy Use by Fuel, IACH

ENERGY	UNIT	MBTU/YR	KBTU SQFT-YR	TOTAL $	$/SQFT-YR
Electricity	10.3 mil kWh	119,355	302	421,300	1.07
Natural gas	2.2 mil therm	230,538	583	977,500	2.47
Total		349,893	885	1,398,800	3.54

Figure 1-3 shows the breakdown of energy costs at IACH. Absorption cooling accounts for about 42% of the total cost. Figures 1-4 and 1-5 give breakdowns of electricity and gas costs respectively. Domestic hot water (DHW) comprises a very small part of the cost while gas used for cooling is much higher than the amount used for heating.

COMPARISON OF HOSPITAL ENERGY USE

FIGURE 1-2

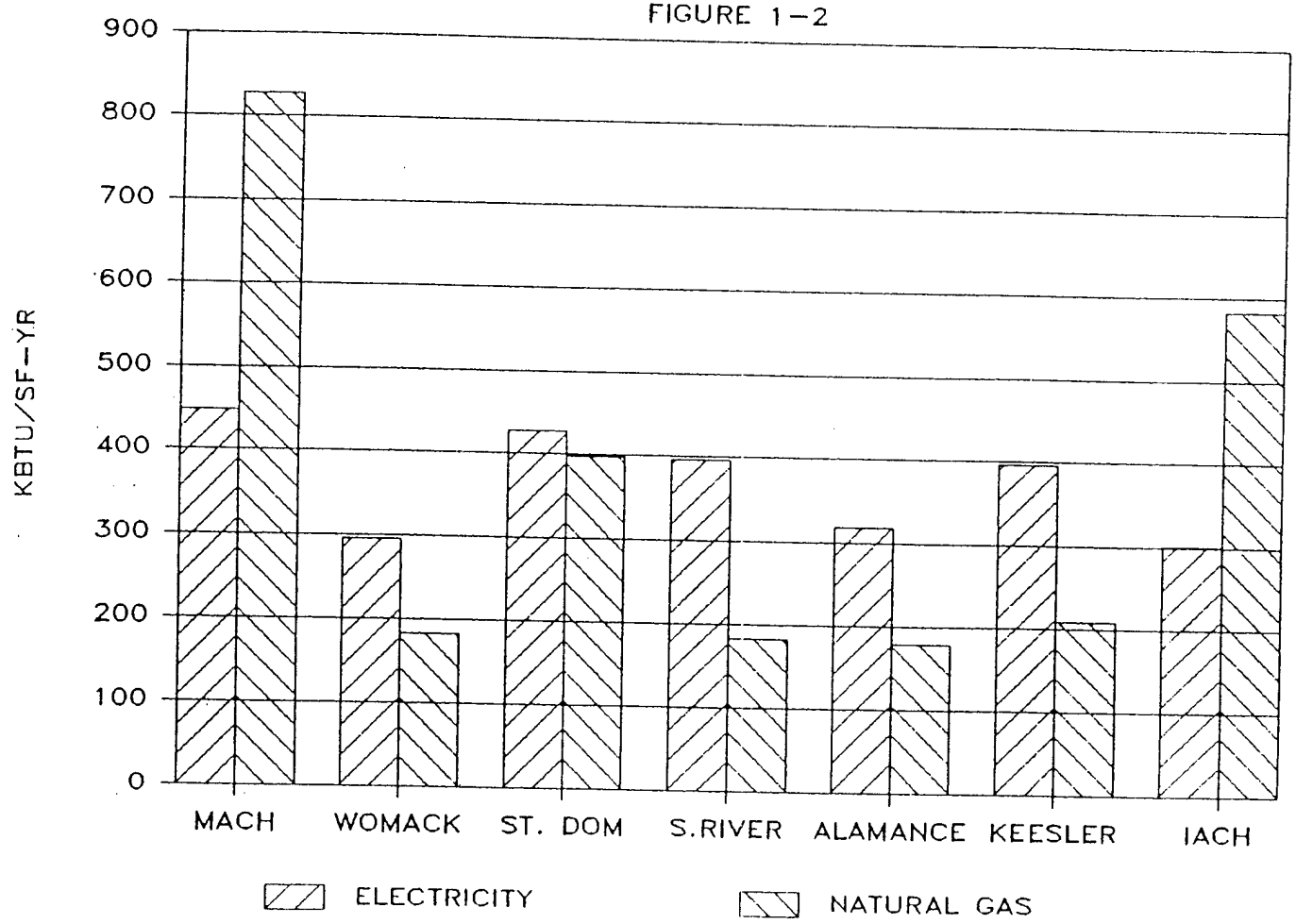

FIGURE 1-2	**IRELAND ARMY HOSPITAL** **DATE: 4/86**	IES/KE INC. chapel hill, north carolina sacramento, california

BREAKDOWN OF TOTAL ENERGY COSTS

FIGURE 1-3

Total Cost = $1,398,800

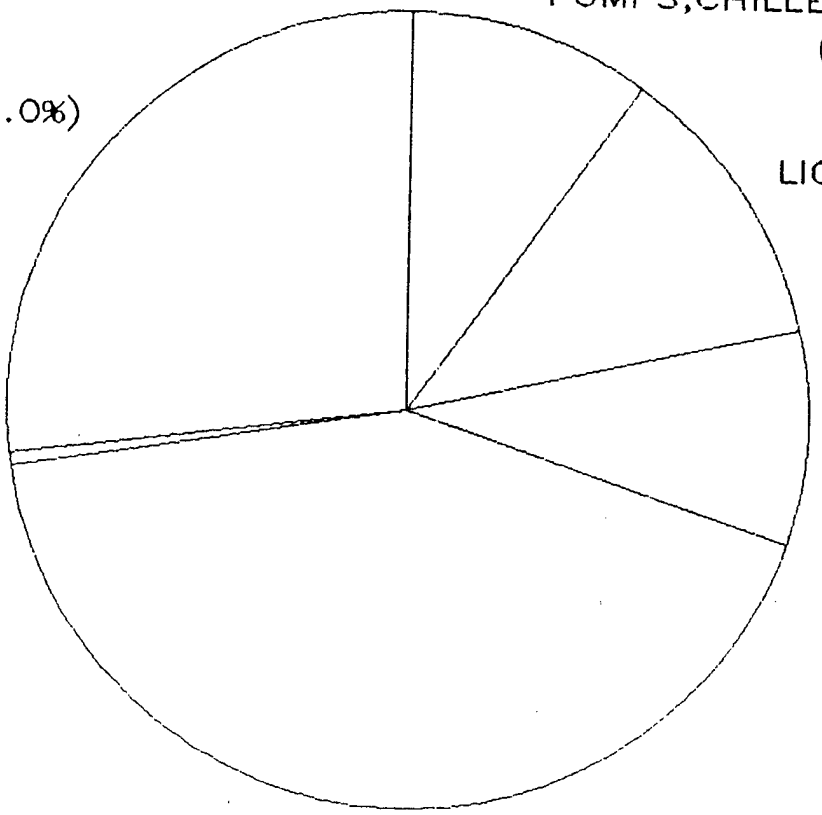

FIGURE 1-3	IRELAND ARMY HOSPITAL DATE: 4/86	IES/KE INC. chapel hill, north carolina sacramento, california

BREAKDOWN OF ELECTRICITY COST

FIGURE 1–4

Total Cost = $421,300

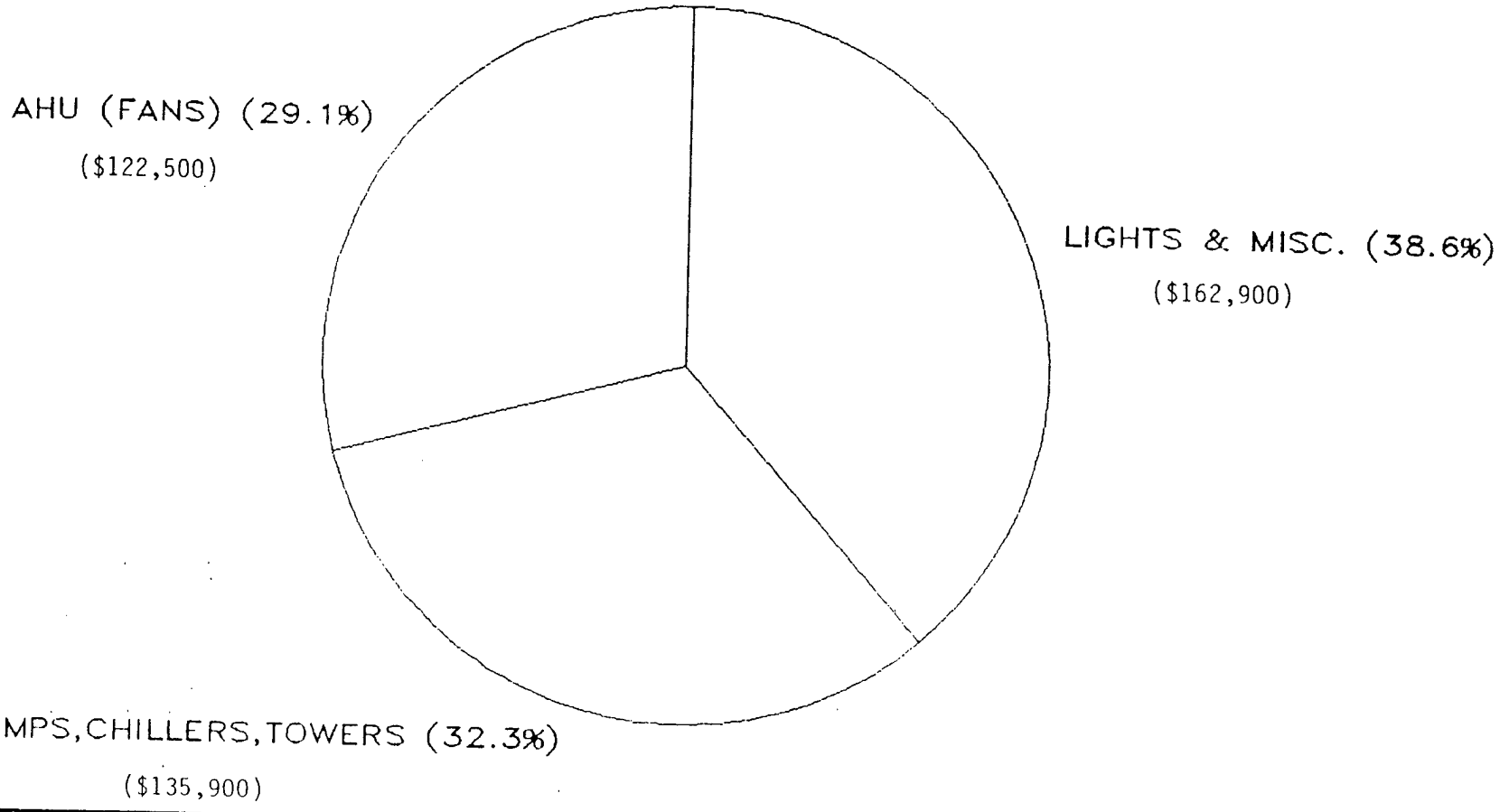

FIGURE 1–4	IRELAND ARMY HOSPITAL DATE: 4/86	IES/KE INC. chapel hill, north carolina sacramento, california

BREAKDOWN OF NATURAL GAS COST

FIGURE 1-5

Total Cost = $977,500

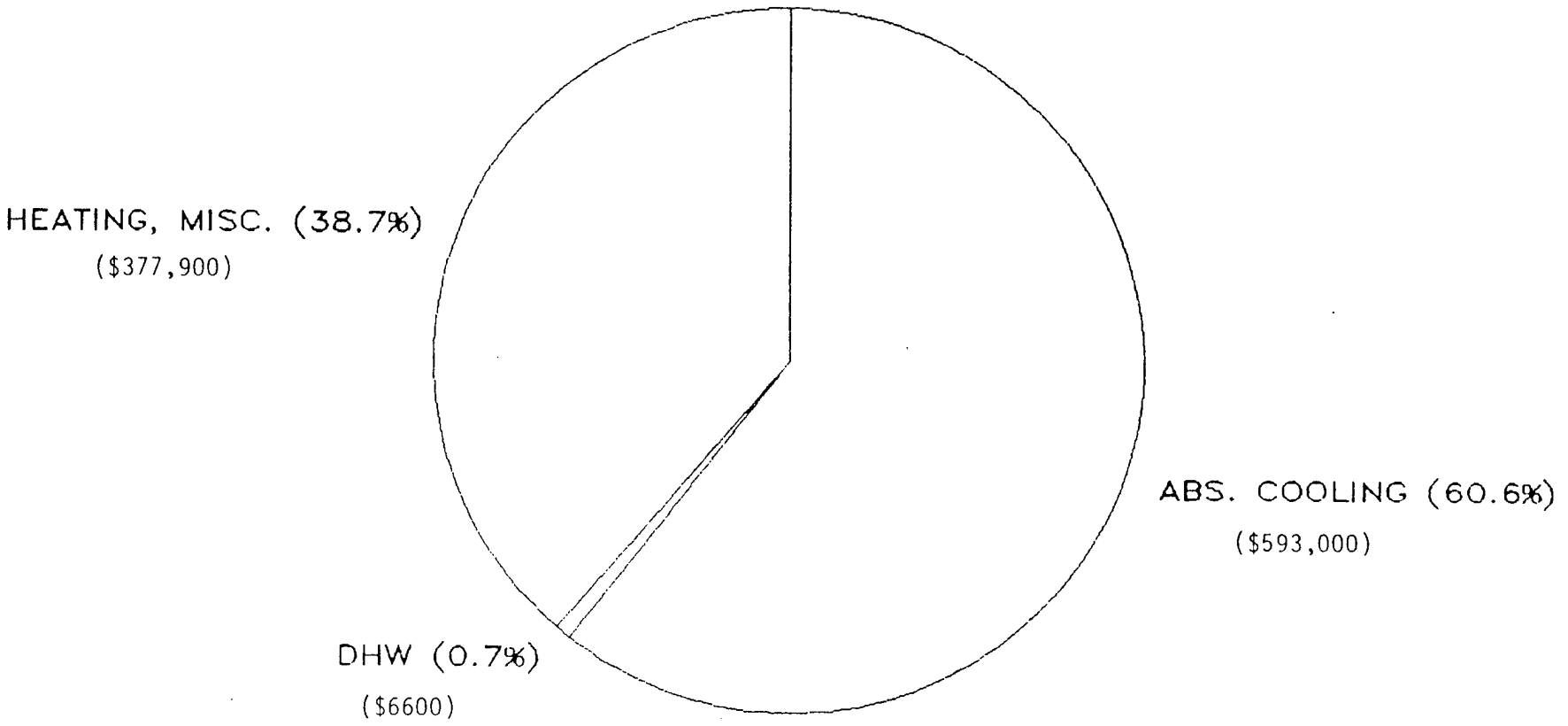

FIGURE 1-5	IRELAND ARMY HOSPITAL DATE: 4/86	IES/KE INC chapel hill, north carolina sacramento, california

1.2.2 Auxiliary Facilities

The estimated current cost of energy used by the Auxiliary Facilities is shown in Table 1-3. This estimate is from the Carrier models as described in Chapters 12-19. As indicated, the estimated cost is $1.17/sqft. The total estimated cost of energy for these buildings is $166,047/yr.

Table 1-3 Total Estimated Energy Use, Auxillary Facilities, IACH

BUILDING NUMBER	SQ FT	$	$/SQ FT	MBTU	KBTU/SF
850	29772	34409	$1.16	8802.4	295.7
853	31800	29752	$0.94	7854.8	247.0
855	10731	10438	$0.97	2826.6	263.4
856	10731	10438	$0.97	2826.6	263.4
857	10731	10438	$0.97	2826.6	263.4
2000	9500	16708	$1.76	4491.0	472.7
2724	17120	23974	$1.40	6674.2	389.8
5949	10520	15957	$1.52	3522.7	334.9
6289	11170	13933	$1.25	3740.4	334.9
TOTAL	142075	166047	$1.17	43565.3	306.6

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In Table 1-4 the estimated consumption by fuel type is shown. The cost of electricity used is about twice that of gas. Table 1-5 and Figure 1-6 show the breakdown of energy use for heating, cooling, fans and pumps, and other for the Auxiliary Facilities. Heating energy, including central plant losses, accounts for over 25% of the total with cooling comprising only 7% of the total use, unlike IACH where cooling dominates. All the values in Tables 1-4 and 1-5 are based on estimated energy consumption using the Carrier E20-II program.

Table 1-4 Estimated Energy Consumption by Type, Auxillary Facilities

BUILDING NUMBER	ELECTRICITY $	ELECTRICITY *MBTU	NATURAL GAS $	NATURAL GAS MBTU	#2 FUEL OIL $	#2 FUEL OIL MBTU	TOTAL $	TOTAL MBTU
850	14484	4103.1	19925	4699.3	0	0	34409	8802.4
853	17658	5002.3	12094	2852.5	0	0	29752	7854.8
855	7688	2177.9	2750	648.7	0	0	10438	2826.6
856	7688	2177.9	2750	648.7	0	0	10438	2826.6
857	7688	2177.9	2750	648.7	0	0	10438	2826.6
2000	11603	3287.0	5105	1204	0	0	16708	4491.0
2724	21502	6091.2	2472	583	0	0	23974	6674.2
5949	9021	2555.5	334	78.7	6602	888.5	15957	3522.7
6289	9579	2713.4	4354	1027	0	0	13933	3740.4
TOTAL	106911	30286.2	52534	12390.6	6602	888.5	166047	43565.3

Table 1-5 Energy Use Breakdown in MBTU, Auxillary Facilities

BUILDING NUMBER	HEATING	COOLING	FANS & PUMPS	DHW	LIGHTS	MISC EQUIP	TOTAL
850	3290.8	0	625.2	469.3	1775.9	2641.2	8802.4
853	2587.3	465.2	3006.8	265.1	765.2	765.2	7854.8
855	522.2	318.4	1267.7	126.5	118.4	473.4	2826.6
856	522.2	318.4	1267.7	126.5	118.4	473.4	2826.6
857	522.2	318.4	1267.7	126.5	118.4	473.4	2826.6
2000	1113.2	350.7	999.2	90.8	644.5	1292.6	4491.0
2724	516.7	782.7	3202.5	66.3	1322.7	783.3	6674.2
5949	888.5	259.4	783.0	78.7	815.3	697.8	3522.7
6289	943.4	275.4	831.4	83.6	865.7	740.9	3740.4
TOTAL	10906.5	3088.6	13251.2	1433.3	6544.5	8341.2	43565.3

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* MBTU @ 11,600 BTU/kwh

ENERGY USE BREAKDOWN, AUX. FACILITIES

FIGURE 1-6

Total = 43565.3 MBIU/YR

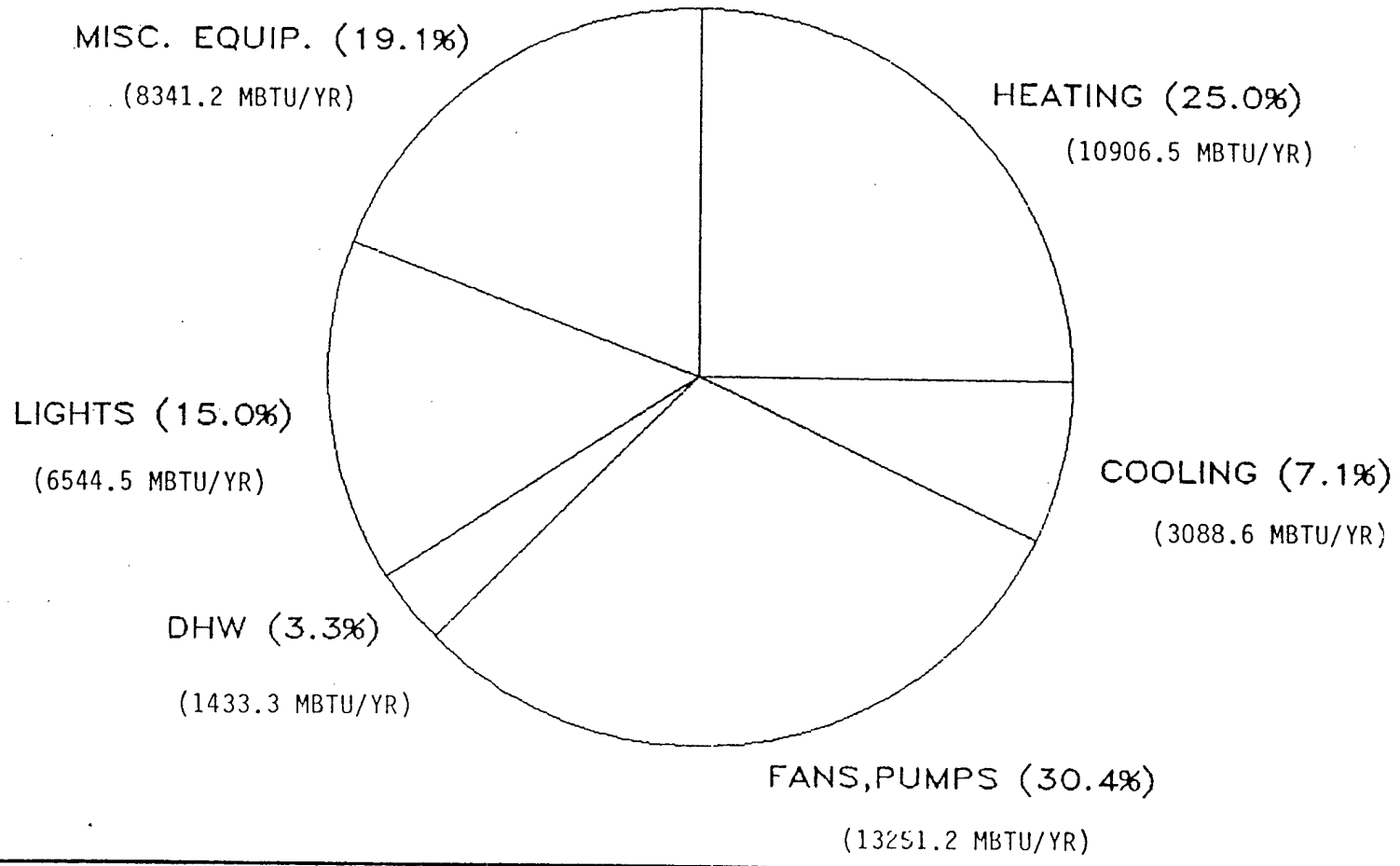

FIGURE 1-6	**IRELAND ARMY HOSPITAL** **DATE: 4/86**	IES/KE INC. chapel hill, north carolina sacramento, california

1.3 Energy Conservation Analysis

1.3.1 ECOs Investigated

All of the ECOs shown in the checklist in Annex A (SOW) were investigated for each building in the SOW. The checklist for IACH is shown in pages 3-2 to 3-9. Similar checklists for each Auxiliary Facility appear in the respective chapter for that building (Chapters 12-19). A "Yes" means that the ECO seemed feasible in the field and was considered further. All those marked "Yes" are described in this report, although after further analysis some resulted in not being recommended. A "No" on the checklist indicates that the ECO was unfeasible as explained. A comparison of the SOW checklist and each of the building lists will show that many additional ECOs were investigated.

All of the ECOs at IACH were evaluated relative to the base case simulation on BLAST. The BLAST runs were run interactively, ie assuming implementation of previously analyzed ECOs. The order of the BLAST runs is shown in Table 1-6. Boiler ECOs were manually calculated after determining the boiler loads by adding the results of the last BLAST run to the results of the last Carrier run for buildings 850, 855, 856, 857, and bldg. 853 which are also served by the boiler plant.

Table 1-6. Order of Computer Runs to Account for Interaction

1) base case as observed during field investigation
2) implement planned projects (Table 4-1 for IACH)
*3) implement no and low (<$3000) cost improvements in order: envelope, lighting, misc equip, HVAC, utility
4) implement envelope ECOs
5) implement lighting ECOs
6) implement ECOs to misc equip, e.g., elevators, compressors
7) implement HVAC ECOs
8) implement utility ECOs

---

*For the purpose of analysis low cost/no cost projects were defined as <$3000. After the ECOs were analyzed DEH selected which projects it will accomplish in house. These projects may have a cost higher than $3000. Similarly some projects costing less than $3000 may be programmed for funding with other ECOs.

1.3.2 ECOs Recommended

All of the ECOs recommended for IACH are listed in order of SIR in Table 1-7. A total of 36 ECOs are shown. As indicated, the total installed cost is estimated to be $999,644 with an annual savings of $931,447 for a payback of 1.07 years.

The ECO's which are recommended for the Auxiliary Facilities are shown in Tables 1-8 through 1-15. A total investment of $76,855 is expected to save $40,425 for a payback of 1.90 years.

Table 1-7 Recommended ECOs, IACH

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
A-39b	Base load electric chillers when possible	16	80187	0	0.00	90082.0	-6695.0	24486.0
A-10	Calibrate 3 CW pressure controls to reduce leakage through CW valves	94	48256	0	0.00	7856.6	1922.0	9780.9
E-1B	Reset standby timers on elevators	31	6523	0	0.00	2658.5	1848.0	0.0
A-14	Utilize/calibrate present SAT reset controls; 22 systems	693	20978	0	0.03	473.9	493.2	4537.0
A-26	Valve-off steam to pre-heat coils at all RW systems	59	1693	0	0.03	438.5	69.1	341.7
A-1	Program EMCS for start/ stop of AHUs, provide dial timer switches; 24 systems	9819	174471	-316	0.06	266.1	9433.8	33294.8
A-30	Calibrate or provide controls at 6 systems	626	9060	-20	0.07	225.9	225.1	1949.3
A-38	Remove moisture baffles at AHUs 20 & 21	78	1185	0	0.07	152.4	335.6	0.0
A-17	Program EMCS for dry bulb economizer capability for all systems	2561	21676	-79	0.12	128.1	993.8	4284.9
A-2	Adjust dampers & sheaves or replace sheaves &belts to correct OA & EA flows; 30 systems	5132	29225	0	0.18	89.9	499.2	6477.0
A-13	Provide auto SA dampers in three zones	5853	24712	-158	0.24	61.8	1684.6	4425.9
A-11a	Reset 305 FCU T-stats & 5 other T-stats to author-ized setpoints	4880	15165	0	0.32	48.7	354.4	3281.6
A-37	Replace filter access door hardware at 25 AHUs	734	2024	0	0.36	44.6	0.0	477.3
A-25b	Insulate steam and condensate lines	1401	2322	0	0.60	41.7	0.0	547.7
C-1c	Dial timer switch for sub-basement lights	474	1177	0	0.40	31.4	257.5	0.0
A-7	Calibrate humidifier controls at 13 AHUs	409	555	0	0.74	21.9	0.0	130.9

Table 1-7 Recommended ECOs, IACH (continued)

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
A-11b	Provide 478 dual setpoint T-stats & locking covers, calibrate 466 VAV/reheat boxes for new stats	108213	100360	-217	1.08	21.2	5216.7	19326.6
I-10j	Provide a space temp sensor in 16 Zones & prog EMCS for optimal start	10877	14107	-158	0.78	19.4	722.6	2725.6
A-12	Rebuild 4 leaking steam valves	901	1056	0	0.85	18.9	0.0	249.1
F-1	Reduce DHW temperature	3714	2500	0	1.49	18.7	-144.5	710.0
C-1b	Bathroom occupancy sensrs	1794	2253	0	0.80	15.9	492.9	-96.9
A-40b	Replace absorption chiller, varible speed pumping	330581	258606	0	1.28	12.8	-2829.2	63347.4
A-33	Provide a separate AHU for Zone 51	14755	12426	-316	1.22	11.6	1228.0	1908.4
C-2c	Delamping	2967	2646	53	1.10	11.5	579.0	-156.9
A-25a	Provide steam pipe insulation at AHUs 23 & 35	1383	810	0	1.71	9.5	0.0	191.0
A-3	Reduce SA flow with VAV; 5 systems	49383	27159	-1165	1.90	7.1	3507.7	3485.1
C-1a	Occupancy sensors replacing switchplates	624	258	0	2.42	5.2	56.5	-11.1
A-41	Provide integral T-stat valves for 500 steam convectors	72285	23952	-2032	3.30	4.9	362.0	5347.7
B-7	Install air preheater	4812	807	-20	6.11	4.3	-14.6	202.4
I-8	Provide smaller boiler	149881	23524	0	6.37	4.0	0.0	5548.0
I-10f	Provide hardware and program EMCS for chiller optimization	11481	4249	-158	2.81	3.6	1203.7	0.0
C-4b	Exterior fluorescent lamps	2114	558	0	3.79	3.3	122.0	0.0
I-10k	Provide hardware & program EMCS for boiler data loging	56640	0	13434	4.22	2.4	0.0	0.0
C-4a	Efficient ballasts	13731	1718	0	7.99	1.6	376.0	-74.0

Table 1-7 Recommended ECOs, IACH (continued)

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
A-11b	Provide 478 dual setpoint T-stats & locking covers, calibrate 466 VAV/reheat boxes for new stats	108213	100360	-217	1.08	21.2	5216.7	19326.6
I-10j	Provide a space temp sensor in 16 Zones & prog EMCS for optimal start	10877	14107	-158	0.78	19.4	722.6	2725.6
A-12	Rebuild 4 leaking steam valves	901	1056	0	0.85	18.9	0.0	249.1
F-1	Reduce DHW temperature	3714	2500	0	1.49	18.7	-144.5	710.0
C-1b	Bathroom occupancy sensrs	1794	2253	0	0.80	15.9	492.9	-96.9
A-40b	Replace absorption chiller, varible speed pumping	330581	258606	0	1.28	12.8	-2829.2	63347.4
A-33	Provide a separate AHU for Zone 51	14755	12426	-316	1.22	11.6	1228.0	1908.4
C-2c	Delamping	2967	2646	53	1.10	11.5	579.0	-156.9
A-25a	Provide steam pipe insulation at AHUs 23 & 35	1383	810	0	1.71	9.5	0.0	191.0
A-3	Reduce SA flow with VAV; 5 systems	49383	27159	-1165	1.90	7.1	3507.7	3485.1
C-1a	Occupancy sensors replacing switchplates	624	258	0	2.42	5.2	56.5	-11.1
A-41	Provide integral T-stat valves for 500 steam convectors	72285	23952	-2032	3.30	4.9	362.0	5347.7
B-7	Install air preheater	4812	807	-20	6.11	4.3	-14.6	202.4
I-8	Provide smaller boiler	149881	23524	0	6.37	4.0	0.0	5548.0
I-10f	Provide hardware and program EMCS for chiller optimization	11481	4249	-158	2.81	3.6	1203.7	0.0
C-4b	Exterior fluorescent lamps	2114	558	0	3.79	3.3	122.0	0.0
I-10k	Provide hardware & program EMCS for boiler data loging	56640	0	13434	4.22	2.4	0.0	0.0
C-4a	Efficient ballasts	13731	1718	0	7.99	1.6	376.0	-74.0

Table 1-7 Recommended ECOs, IACH (continued)

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
C-4c	Replace boiler plant ltg	9768	1088	0	8.98	1.4	238.0	0.0
B-4	Repair steam line to Bldgs 850 & 853	120880	5313	0	22.75	1.1	0.0	1253.1
	TOTALS	999644	922599	8848	1.07	NA	22538.1	197970.5

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Table 1-8 ECOs Recommended, Building # 850

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
A-27	Night setback for pool area	16	1519	0	0.01	1463.6	52.7	314.4
F-1	Reduce DHW temp.	16	707	0	0.02	1112.2	0.0	166.7
A-25	Insulate and repair misc piping	464	713	0	0.65	38.7	0.0	168.2
F-2	Repair/replace DHW tank insulation	505	319	0	1.58	15.9	0.0	75.2
C-1	Occupancy sensors and separate light switches	513	196	0	2.62	3.5	70.2	-12.3
E-9	Pool cover	8776	1185	0	7.41	2.2	0.0	279.4
C-4a	Replace incandescant exit lighting w/fluorescent	292	48	0	6.08	1.5	17.1	-3.0
	TOTALS	10582	4687	0	2.26	NA	140.0	988.6

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Table 1-9 Recommended ECOs, Building # 853

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
F-1	Reduce DHW temp.	16	307	0	0.05	482.4	0.0	72.3
F-2	Replace steam pipe insulation	244	1415	0	0.17	146.0	0.0	333.7
D-3	Add R-11 insulation above ceiling	3229	791	0	4.08	5.8	24.0	166.5
C-4	Replace incandescent lighting with fluorescent	451	116	0	3.89	2.3	42.0	-7.7
C-1	Occupancy sensors for laundry & latrines	410	87	0	4.71	1.9	31.8	-5.9
A-19	Refrigerant heat recovery	3098	231	0	13.41	1.9	0.0	54.4
E-8	Replace fan coil motors with energy efficient mtrs	10007	2494	0	4.01	1.9	1005.6	-248.9
	TOTALS	17455	5441	0	3.21	NA	1103.4	364.4

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Table 1-10 Recommended ECOs, Building # 856

ECO AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
F-1 Reduce DHW temperature	16	146	0	0.11	230.2	0.0	34.5
A-28 Clean refrigerator condenser coils	59	43	0	1.37	3.3	15.0	-2.3
D-7 Add wall insulation	6827	568	0	12.02	2.0	15.9	120.7
D-3 Add addtl ceiling insltn	2453	144	0	17.03	1.4	6.9	28.2
Total	9355	901	0	10.38	NA	37.8	181.1

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Table 1-11 Recommended ECOs, Buildings #855 and #857

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
F-1	Reduce DHW temperature	31	293	0	0.11	237.6	0.0	69.0
A-28	Clean refrigerator condenser coils	117	86	0	1.36	3.3	30.0	-4.6
D-7	Add wall insulation	13655	1136	0	12.02	2.0	31.8	241.4
D-3	Add addtl ceiling insltn	4906	288	0	17.03	1.4	13.8	56.4
	Total	18709	1803	0	10.38	NA	75.6	362.2

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Table 1-12 ECOs Recommended, Building # 2000

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
E-10	Repair dental air compressor	31	2917	0	0.01	1188.8	826.4	0.0
A-27	Night setback/set-up	47	1846	0	0.03	436.4	431.2	76.4
F-1	Reduce DHW temp.	16	238	0	0.07	375.0	0.0	56.2
E-9	Time clock controls of exhaust fans & DHW pump	671	3345	-20	0.20	119.9	79.8	722.5
B-3	Replace boiler burner	842	374	0	2.25	11.2	0.0	88.1
C-2	Delamping	124	99	2	1.23	8.5	33.2	-4.2
F-6	Insulate DHW piping	23	4	0	5.75	4.2	0.0	0.9
A-11	Dead band thermostats	1196	362	0	3.30	3.0	102.6	0.0
C-4	Replace incandescent lgtng with fluorescent	2326	527	0	4.40	2.2	183.0	-28.1
A-5	Close off SA to vestibules	49	6	0	8.17	2.0	0.1	1.4
A-17	Repair economizer control	332	103	-39	5.20	1.9	29.3	0.0
D-8	Window blocking	1960	119	0	16.50	1.2	15.7	15.0
	Totals	7617	9940	-57	0.77	NA	1701.3	928.2

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Table 1-13 ECOs Recommended, Building # 2724

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
F-1	Reduce DHW temperature	16	116	0	0.14	182.2	0.0	27.3
A-27	Night setback controls (stand alone)	939	5840	-20	0.16	63.2	1612.7	34.7
E-9	Timeclock control of exhaust fans	1251	1982	-20	0.64	34.2	156.0	337.5
A-11	Dead band thermostats	1395	834	0	1.67	6.0	236.4	0.0
A-5	Shut off vestibule heat, adjust door	121	44	0	2.75	5.3	3.1	7.7
C-4	Replace incand lgt w/fluor	564	109	0	5.17	2.3	32.2	-1.1
A-28	Clean lounge refrg coils	10	4	0	2.50	2.0	1.2	0.0
	TOTALS	4296	8929	-40	0.48	NA	2041.6	406.1

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Table 1-14 ECOs Recommended, Building # 5949

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON ENERGY	PAYBACK YRS	SIR	ELEC MBTU	SAVINGS FUEL GAS MBTU	SAVINGS FUEL OIL MBTU
F-1	Reduce DHW temperature	16	165	0	0.10	259.6	0.0	38.9	0.0
E-9	Timeclock control of exhaust fans	1482	3912	-20	0.38	52.3	104.1	0.0	477.0
C-2	Delamping	63	26	1	2.33	4.0	10.2	0.0	-1.4
A-11	Dead band thermostats	1595	401	0	3.98	2.5	113.6	0.0	0.0
A-5	Close off SA to vestibule, adjust door	95	14	0	6.79	1.9	0.3	0.0	1.7
A-17	Repair economizer control	698	168	-39	5.41	1.9	47.5	0.0	0.0
	TOTALS	3949	4686	-58	0.85	NA	275.7	38.9	477.3

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Table 1-15 ECOs Recommended, Building # 6289

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
F-1	Reduce DHW temperature	16	118	0	0.14	185.5	0.0	27.8
E-9	Timeclock control of exhaust fans &DHW cir pmp	870	3288	-20	0.27	87.6	143.2	656.3
F-2	Repair leaking faucet	24	18	0	1.33	12.0	0.0	4.2
C-2	Delamping	669	253	7	2.57	3.9	86.5	-12.3
C-4	Replace incand ltg w/fluor	2217	390	0	5.68	1.8	133.2	-19.0
A-5	Close off SA to vestibule	99	10	0	9.90	1.5	0.4	2.0
A-11	Dead band thermostats	997	129	0	7.73	1.3	36.6	0.0
	TOTALS	4892	4206	-13	1.17	NA	399.9	659.0

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1.3.3 Projects Developed

Table 1-16 lists all project funding categories. Table 1-17 lists the projects developed in this report. Each type of project and the individual ECOs contained in it are described in more detail in section 1.5. The total estimated cost is $1,076,499 while the annual dollar savings is $971,872. Projects were programmed based on the funding categories shown in Table 1-16.

Table 1-16. Project Funding Categories, Ft. Knox

- ECIP: Cost over $200,000, SIR over 1.0
- QRIP: Cost under $100,000, Payback under 2 yrs.
- OSDPIF: Cost of $100,000 or more, Payback under 4 yrs.
- PECIP: Cost of $3,000 or more, Payback under 4 yrs.
- LC/NC: Projects to be completed by the Director of Engineering and Housing or with DEH funds.

Table 1-17, Summary of Projects Developed, IACH and Auxillary Facilities

PROJECT	*INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON-ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU	SAVINGS #2 OIL MBTU
ECIP #1	617635	292499	-178	2.11	7.7	-1640.1	70350.9	0.0
QRIP #1	65132	289356	-1501	0.23	66.3	15923.4	54987.1	0.0
QRIP #2	4020	5583	0	0.72	35.0	0.0	1316.7	0.0
QRIP #3	68210	35085	13276	1.41	9.9	1215.8	7262.6	0.0
ORIP #4	25470	39664	-552	0.65	22.4	2989.4	6866.0	0.0
OSDPIF #1	146033	143643	-317	1.02	14.4	9948.4	25176.1	477.0
PECIP #1	73186	25008	-2032	3.19	5.1	362.0	5596.8	0.0
PECIP #2	39101	11549	63	3.37	2.0	2761.3	-432.5	-1.4
LC/NC	37712	120805	-79	0.31	NA	-2746.8	30775.3	1.7
TOTALS	1076499	963192	8680	1.11	NA	28813.4	201899.0	477.3

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* Costs are in 1985 dollars, Programmed dates and cost are dependent on the availability of funds.

1.4 Projected Energy Costs

1.4.1 IACH

Table 1-18 shows the BLAST estimates of current and projected energy consumption and costs for IACH. As indicated gas consumption is expected to drop by $840,700, a large portion of this being due to the elimination of absorption cooling. While the installation of electric chillers will cause an increase in electrical consumption the electricity saved by other ECOs will more than offset this increase to yield a drop in electricity costs by $74,500. The overall impact of the ECOs at IACH is an energy savings of $915,200 or 65%, or a reduction from about $3.54/sq.ft. to about $1.22/sq.ft. Figure 1-7 compares these numbers with other hospitals.

A 65% reduction in energy costs is very high. Previous studies by IES/KE show an average of 25-30%. The reason for this large savings is the replacement of the existing absorption cooling system which is very inefficient. Simply converting to electric cooling with no other ECOs would save nearly $435,000. The fact that the savings from EOCs A-39b and A-40b in Table 1-7 is not $435,000 is explained by the fact that all planned projects and envelope, lighting, and HVAC ECOs were assumed implemented prior to ECO A-40b.

The reduction in the amount of reheating of cooled air also accounts for a large portion of the savings.

Table 1-18. Estimated Current and Projected Energy Use, IACH.

FUEL	CURRENT MBTU	$	PROJECTED MBTU	$
gas	230538	977500	32273	136800
electricity	119355	421300	98233	346800
Total	349893	1398800	130506	483600

Referring to Figure 1-1 natural gas consumption is expected to drop from 583 to 82 KBTU/sqft/yr. Electricity will go from 302 to 249 KBTU/sqft/yr for a total of 331 KBTU/sqft/yr.

Note that the total annual savings shown in Table 1-7 for all ECOs is $931,447 while the savings in Table 1-18 is $915,200. There are three reasons for this discrepancy.

1) Table 1-18 is based on the final BLAST analysis which includes planned projects as well as all of the ECOs. Table 4-1a lists the planned projects which will have an effect on energy consumption. All analyses in this report assume the implementation of these projects so the savings does not show in the ECOs, but does in the before and after BLAST runs.

2) Table 1-7 includes increased maintenance costs and non-energy savings, Table 1-18 does not.

3) Table 1-7 includes savings for the central boiler plant ECOs (B-4, B-7, and I-8). Since the boiler plant serves buildings 850, 853, 855, 856, and 857 in addition to the hospital, all of the savings for these ECOs cannot be applied to the hospital. After the implementation of all ECOs in the hospital and auxiliary facilities the hospital will account for approximately 77% of the boiler plant consumption.

1.4.2 Auxiliary Facilities

In Table 1-19 energy costs by fuel type before and after conservation are shown. As indicated, energy costs are projected to decrease by about $40,600. Approximately $20,400 of the savings is electricity, with gas comprising approximately $16,700, and fuel oil accounting for about $3500.

Table 1-19 Energy Costs Before and After ECOs, Auxillary Facilities

BUILDING NUMBER	ELECTRICITY $ BEFORE	ELECTRICITY $ AFTER	NATURAL GAS $ BEFORE	NATURAL GAS $ AFTER	#2 FUEL OIL $ BEFORE	#2 FUEL OIL $ AFTER	TOTAL $ BEFORE	TOTAL $ AFTER
850	14484	13989	19925	15733	0	0	34409	29722
853	17658	13763	12094	10548	0	0	29752	24311
855	7688	7555	2750	1982	0	0	10438	9537
856	7688	7555	2750	1982	0	0	10438	9537
857	7688	7555	2750	1982	0	0	10438	9537
2000	11603	5598	5105	1170	0	0	16708	6768
2724	21502	14290	2472	755	0	0	23974	15045
5949	9021	8047	334	169	6602	3055	15957	11271
6289	9579	8171	4354	1556	0	0	13933	9727
TOTAL	106911	86523	52534	35877	6602	3055	166047	125455

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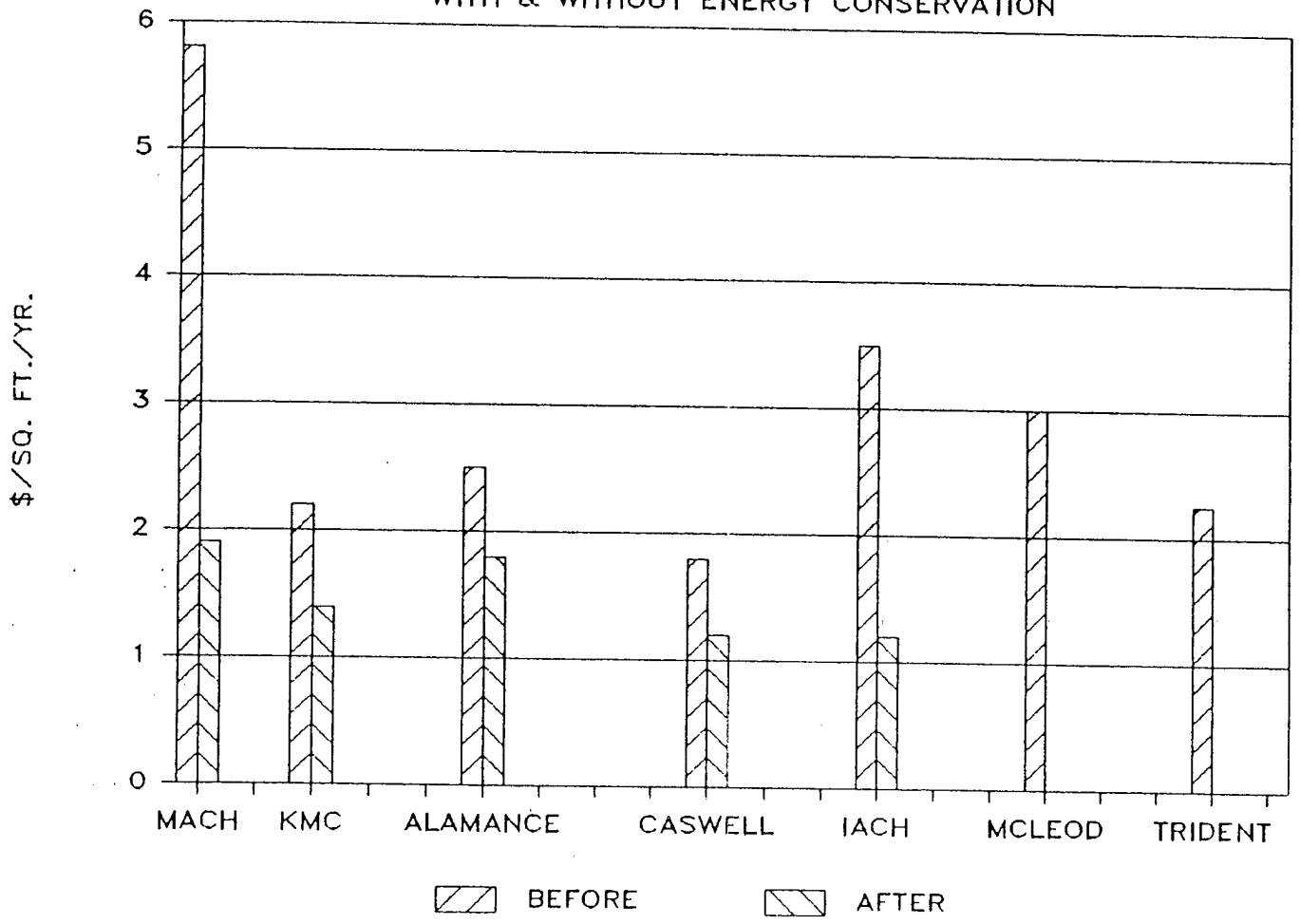

FIGURE 1–7

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1.4.3 IACH and Auxiliary Facilities

Table 1-20 summarizes the current energy costs for IACH and the Auxiliary Facilities. Without any energy conservation efforts these costs are expected to increase from $1,573,058 in 1985 to 1,692,848 in 1988 based on DOE projections of regional energy price increases. By implementing all measures recommended in this report the energy costs in 1988 are expected to be $651,561 for an avoided cost of $1,041,287 in 1988 dollars.

Table 1-20. Current Energy Costs, IACH and Auxiliary Facilities

	Nat Gas ($)	Elec ($)	Fuel Oil ($)
IACH	977,500	421,300	0
Auxiliary Facilities	106,911	52,534	6602
Underground Steam Losses	8,211	0	0
Totals	1,092,622	473,834	6602

1.5 Energy Plan

Table 1-17 summarizes the projects developed.

The Lost/No Cost Improvements listed in Table 1-21 should be implemented immediately. Since the interim report presentation several of the projects listed in Table 1-21 have already been implemented.

The QRIP, OSDPIF, and PECIP projects are outlined in Tables 1-22 through 1-28. These projects have been programmed for 1987. If possible ORIPs 1, 2, and 4 should be implemented sooner since they all have payback periods less than 1 year.

The ECIP project is summarized in Table 1-29. It has been programmed for 1988 per paragraph 3 annex D of the SOW.

Figure 1-8 shows the impact on energy costs that can be achieved by iplementing the plan outlined in this report. The energy prices are based on escalations in energy costs projected by DOE for the Kentucky region.

1.6 The Role of Hospital Command and the Hospital Engineer.

Several low cost/no cost measures to reduce energy consumption in the hospital could be implemented in-house by the hospital engineer and his maintenance staff. These measures could save as much as $100,000/yr at IACH. In order for this to happen, however, both MEDDAC and DEH must provide active guidance and support, in the following actions:

- set and maintain authorized temperature and humidities in all areas, at all times.
- clarify that energy management is an important element of the hospital engineer's job.
- install metering on gas and electricity; read and analyze the data at least montly; use to help evaluate the hospital engineer's performance.
- utilize the full capability of the Delta energy management system to set back the temperatures during unoccupied periods.

Hospital command should make it clear to all hospital personnel that it supports conservation efforts by the maintenance staff and that all temperature and humidity guidelines will be enforced. Situations may arise in which temperatures in non critical areas temporarily exceed comfort levels because of energy conservation efforts by the hospital engineer. When complaints arise because of such circumstances hospital command must be prepared to re-assert its support for the hospital engineers efforts.

Energy conservation requires a great deal of cooperation among hospital personnel, but as the numbers in this report reflect, the savings can be enormous.

Table 1-21, Low Cost/No Cost Improvements

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON-ENERGY	PAYBACK YRS	SIR	ELEC SAVINGS MBTU	GAS SAVINGS MBTU	#2 OIL SAVINGS MBTU
IACH									
A-7	Calibrate humidifier controls at 13 AHUs	409	555	0	0.74	21.9	0.0	130.9	0.0
A-17	Program EMCS for dry bulb economizer capability for all systems	2561	21676	-79	0.12	128.1	993.8	4284.9	0.0
A-26	Valve-off steam to pre-heat coils at all Re-heat systems	59	1693	0	0.03	438.5	69.1	341.7	0.0
A-39b	Base load electric chillers when possible	16	80187	0	.00	90082.0	-6695.0	24486.0	0.0
E-1b	Reset standby timers on elevators	31	6523	0	.00	2658.5	1848.0	0.0	0.0
Building 850									
A-27	Night setback for pool area	16	1519	0	0.01	1463.6	52.7	314.4	0.0
F-1	Reduce DHW temperature	16	707	0	0.02	1112.2	0.0	166.7	0.0
Building 853									
D-3	Add R-11 insulation above ceiling	3229	791	0	4.08	5.8	24.0	166.5	0.0
F-1	Reduce DHW temperature	16	307	0	0.05	482.4	0.0	72.3	0.0
Building 856									
A-28	Clean refrigerator condenser coils	59	43	0	1.37	3.3	15.0	-2.3	0.0
D-3	Add additional ceiling insulation	2453	144	0	17.03	1.4	6.9	28.2	0.0
D-7	Add wall insulation	6827	568	0	12.02	2.0	15.9	120.7	0.0
F-1	Reduce DHW temperature	16	146	0	0.11	230.2	0.0	34.5	0.0

Table 1-21, continued, Low Cost/No Cost Improvements

ECO	DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON-ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU	SAVINGS #2 OIL MBTU
Buildings 855 & 857									
A-28	Clean refrigerator condenser coils	117	86	0	1.36	3.3	30.0	-4.6	0.0
D-3	Add additional ceiling insulation	4906	288	0	17.03	1.4	13.8	56.4	0.0
D-7	Add wall insulation	13655	1136	0	12.02	2.0	31.8	241.4	0.0
F-1	Reduce DHW temperature	31	293	0	0.11	237.6	0.0	69.0	0.0
Building 2000									
A-5	Close off SA to vestibules	49	6	0	8.17	2.0	0.1	1.4	0.0
B-3	Replace boiler burner	842	374	0	2.25	11.2	0.0	88.1	0.0
D-8	Window blocking	1960	119	0	16.47	1.2	15.7	15.0	0.0
E-10	Repair dental air compressor	31	2917	0	0.01	1188.8	826.4	0.0	0.0
F-1	Reduce DHW temperature	16	238	0	0.07	375.0	0.0	56.2	0.0
Building 2724									
A-5	Shut off vestibule heat and adjust door	121	44	0	2.75	5.3	3.1	7.7	0.0
A-28	Clean lounge refrigerator coils	10	4	0	2.50	2.0	1.2	0.0	0.0
F-1	Reduce DHW temperature	16	116	0	0.14	182.2	0.0	27.3	0.0
Building 5949									
A-5	Close off SA to vestibule & adjust door	95	14	0	6.79	1.9	0.3	0.0	1.7
F-1	Reduce DHW temperature	16	165	0	0.10	259.6	0.0	38.9	0.0

Table 1-21, continued, Low Cost/No Cost Improvements

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON-ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU	SAVINGS #2 OIL MBTU
Building 6289									
A-5	Close off SA to vestibule	99	10	0	9.90	1.5	0.4	2.0	0.0
F-1	Reduce DHW temperature	16	118	0	0.14	185.5	0.0	27.8	0.0
F-2	Repair leaking faucet	24	18	0	1.33	12.0	0.0	4.2	0.0
TOTALS		37712	120805	-79	0.31	NA	-2746.8	30775.3	1.7

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Table 1-22, QRIP Project #1, Misc. Improvements

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON-ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
A-1	Program EMCS for start/stop of AHUs, provide dial timer switches; 24 systems	9819	174471	-316	0.06	266.1	9433.8	33294.8
A-2	Adjust dampers & sheaves or replace sheaves & belts to correct OA & EA flows; 30 systems	5132	29225	0	0.18	89.9	499.2	6477.0
A-3	Reduce SA flow with VAV; 5 systems	49383	27159	-1165	1.90	7.1	3507.7	3485.1
A-10	Calibrate 3 CW pressure controls to reduce leakage through CW valves	94	48256	0	.00	7856.6	1922.0	9780.9
A-30	Calibrate or provide controls at 6 systems	626	9060	-20	0.07	225.9	225.1	1949.3
A-38	Remove moisture baffles at AHUs 20 & 21	78	1185	0	0.07	152.4	335.6	0.0
TOTALS		65132	289356	-1501	0.23	66.3	15923.4	54987.1

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Table 1-23, QRIP Project #2, Insulate Piping

ECO AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON-ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
IACH							
A-25a Provide steam pipe insulation at AHUs 23 & 35	1383	810	0	1.71	9.5	0.0	191.0
A-25b Insulate steam and condensate lines	1401	2322	0	0.60	41.7	0.0	547.7
Building 850							
A-25 Insulate and repair misc. piping	464	713	0	0.65	38.7	0.0	168.2
F-2 Repair/replace DHW tank insulation	505	319	0	1.58	15.9	0.0	75.2
Building 853							
F-2 Replace steam pipe insulation	244	1415	0	0.17	146.0	0.0	333.7
Building 2000							
F-6 Insulate DHW piping	23	4	0	5.75	4.2	0.0	0.9
TOTALS	4020	5583	0	0.72	35.0	0.0	1316.7

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Table 1-24, QRIP Project #3, EMCS Expansion

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON-ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
A-14	Utilze/calibrate present SAT reset controls; 22 systems	693	20978	0	0.03	473.9	493.2	4537.0
I-10j	Provide a space temp sensor in 16 zones & prog EMCS for optimal start	10877	14107	-158	0.78	19.4	722.6	2725.6
I-10k	Provide hardware & program EMCS for boiler data loging	56640	0	13434	4.22	2.4	0.0	0.0
TOTALS		68210	35085	13276	1.41	9.9	1215.8	7262.6

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Table 1-25, QRIP Project #4, Heat Recovery, Ductwork, Coil Improvements

ECO AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON-ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
IACH							
A-13 Provide auto SA dampers in three zones	5853	24712	-158	0.24	61.8	1684.6	4425.9
A-33 Provide a separate AHU for zone 51	14755	12426	-316	1.22	11.6	1228.0	1908.4
A-37 Replace filter access door hardware at 25 AHUs	734	2024	0	0.36	44.6	0.0	477.3
Building 853							
A-19 Refrigerant heat recovery	3098	231	0	13.41	1.9	0.0	54.4
Building 2000							
A-17 Repair economizer control	332	103	-39	5.19	1.9	29.3	0.0
Building 5949							
A-17 Repair economizer control	698	168	-39	5.41	1.9	47.5	0.0
TOTALS	25470	39664	-552	0.65	22.4	2989.4	6866

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Table 1-26, OSDPIF Project #1, Misc. Improvements

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON-ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU	SAVINGS #2 OIL MBTU
IACH									
A-11a	Reset 305 FCU T-stats & 5 other T-stats to authorized setpoints	4880	15165	0	0.32	48.7	354.4	3281.6	0.0
A-11b	Provide 478 Dual set-point T-stats & locking covers, calibrate 466 VAV/ reheat boxes for new stats	108213	100360	-217	1.08	21.2	5216.7	19326.6	0.0
F-1	Reduce DHW temp. (includes new DHW heater for pathology)	3714	2500	0	1.49	18.7	-144.5	710.0	0.0
Building 850									
E-9	Pool Cover	8776	1185	0	7.41	2.2	0.0	279.4	0.0
Building 853									
E-8	Replace fan coil motors with energy efficient motors	10007	2494	0	4.01	1.9	1005.6	-248.9	0.0
Building 2000									
A-11	Dead band thermostats	1196	362	0	3.30	3.0	102.6	0.0	0.0
A-27	Night setback/set-up	47	1846	0	0.03	436.4	431.2	76.4	0.0
E-9	Timeclock control of exhaust fans & DHW pump	671	3345	-20	0.20	119.9	79.8	722.5	0.0
Building 2724									
A-11	Dead band thermostats	1395	834	0	1.67	6.0	236.4	0.0	0.0
A-27	Night setback controls	939	5840	-20	0.16	63.2	1612.7	34.7	0.0
E-9	Timeclock control of exhaust fans	1251	1982	-20	0.64	34.2	156.0	337.5	0.0
Building 5949									
A-11	Dead band thermostats	1595	401	0	3.98	2.5	113.6	0.0	0.0
E-9	Timeclock control of exhaust fans	1482	3912	-20	0.38	52.3	104.1	0.0	477.0

Table 1-26, OSDPIF Project #1, Misc. Improvements, continued

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON-ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU	SAVINGS #2 OIL MBTU
Building 6289									
A-11	Dead band thermostats	997	129	0	7.73	1.3	36.6	0.0	0.0
E-9	Timeclock control of exhaust fans & DHW circ. pump	870	3288	-20	0.27	87.6	143.2	656.3	0.0
TOTALS		146033	143643	-317	1.02	14.4	9448.4	25176.1	477.0

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Table 1-27, PECIP Project #1, Misc. Improvements

ECO	AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON-ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
A-12	Rebuild 4 leaking steam valves	901	1056	0	0.85	18.9	0.0	249.1
A-41	Provide integral T-stat valves for 500 steam convectors	72285	23952	-2032	3.30	4.9	362.0	5347.7
TOTALS		73186	25008	-2032	3.19	5.1	362.0	5596.8

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Table 1-28, PECIP Project #2, Lighting Upgrade

ECO	DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON-ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU	SAVINGS #2 OIL MBTU
IACH									
C-1a	Occupancy sensors replacing switchplates	624	258	0	2.42	5.2	56.5	-11.1	0.0
C-1b	Bathroom occupancy sensors	1794	2253	0	0.80	15.9	492.9	-96.9	0.0
C-1c	Dial timer switch for sub-basement lights	474	1177	0	0.40	31.4	257.5	0.0	0.0
C-2c	Delamping	2967	2646	53	1.10	11.5	579.0	-156.9	0.0
C-4a	Efficient ballasts	13731	1718	0	7.99	1.6	376.0	-74.0	0.0
C-4b	Exterior fluorescent lamps	2114	558	0	3.79	3.3	122.0	0.0	0.0
C-4c	Replace boiler plant lighting	9768	1088	0	8.98	1.4	238.0	0.0	0.0
Building 850									
C-1	Occupancy sensors and separate light switches	513	196	0	2.62	3.5	70.2	-12.3	0.0
C-4a	Replace incandescent exit lighting with fluorescent	292	48	0	6.08	1.5	17.1	-3.0	0.0
Building 853									
C-1	Occupancy sensors for laundry & latrines	410	87	0	4.71	1.9	31.8	-5.9	0.0
C-4	Replace incandescent lighting w/ fluorescent	451	116	0	3.89	2.3	42.0	-7.7	0.0
Building 2000									
C-2	Delamping	124	99	2	1.23	8.5	33.2	-4.2	0.0
C-4	Replace incandescent lighting w/ fluorescent	2326	527	0	4.41	2.2	183.0	-28.1	0.0
Building 2724									
C-4	Replace incandescent lighting w/ fluorescent	564	109	0	5.17	2.3	32.2	-1.1	0.0

Table 1-28 continued, PECIP Project #2, Lighting Upgrade

ECO AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON-ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU	SAVINGS #2 OIL MBTU
Building 5949								
C-2 Delamping	63	26	1	2.33	4.0	10.2	0.0	-1.4
Building 6289								
C-2 Delamping	669	253	7	2.57	3.9	86.5	-12.3	0.0
C-4 Replace incandescent lighting w/ fluorescent	2217	390	0	5.68	1.8	133.2	-19.0	0.0
TOTALS	39101	11549	63	3.37	2.0	2761.3	-432.5	-1.4

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Table 1-29, ECIP Project #1, Modify Chillers and Boilers

ECO AND DESCRIPTION	INSTALLED COST	$ SAVINGS ENERGY	$ SAVINGS NON-ENERGY	PAYBACK YRS	SIR	SAVINGS ELEC MBTU	SAVINGS GAS MBTU
A-40b Replace absorption chiller, variable speed pumping	330581	258606	0	1.28	12.8	-2829.2	63347.4
B-4 Repair steam line to Bldgs 850 & 853	120880	5313	0	22.75	1.1	0.0	1253.1
B-7 Install air preheater	4812	807	-20	6.11	4.3	-14.6	202.4
I-8 Provide smaller boiler	149881	23524	0	6.37	4.0	0.0	5548.0
I-10f Provide hardware and program EMCS for chiller optimization	11481	4249	-158	2.81	3.6	1203.7	0.0
TOTALS	617635	292499	-178	2.11	7.7	-1640.1	70350.9

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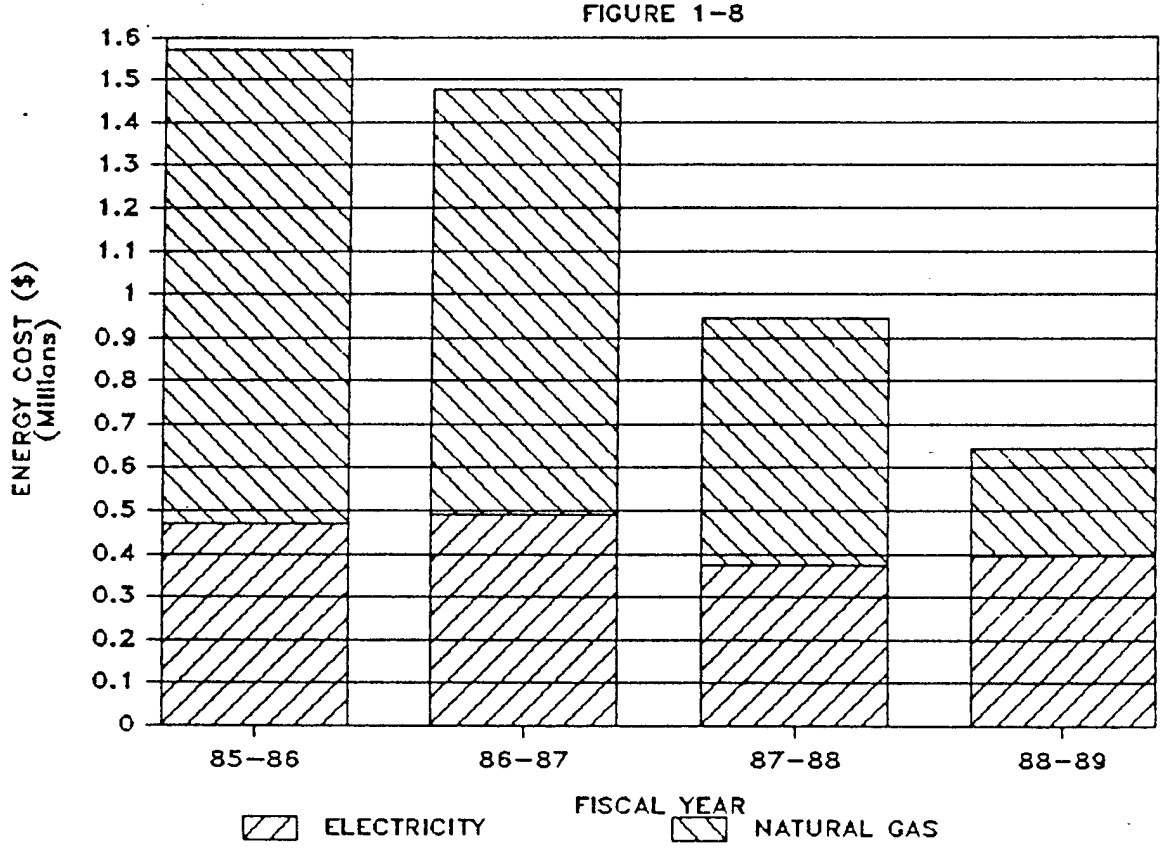
PROJECTED ENERGY COSTS

FIGURE 1-8



*Fuel Oil cost is negligible

FIG 1-8, IACH AND AUXILLARY FACILITIES, FT. KNOX KY

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sacramento, california